North Umpqua Hydropower Mitigation Fund
Project Nomination Form

Project Name: **Mapping native lamprey habitats in the North Umpqua River**

Total Mitigation Funds Requested For this Fiscal Year: $99,860

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Type of Project (mark one that applies):

Wetland/stillwater habitat ___
Terrestrial species connectivity ___
Erosion control ___
Vegetation management ___
Riparian/aquatic species connectivity X

Explanation of why this project is time critical:

Understanding the needs of native lampreys is critical to targeting locations and processes to manage as part of mitigation for impacts from the hydropower project. Lags in our understanding of this will delay our ability to target mitigation to benefit lamprey and monitor their responses. ***Additional restoration needs and new methods and mitigation opportunities have a strong potential to be identified through pioneering investigation of native lamprey ecology in the North Umpqua River.*** These include restoration of passage, placement of instream wood or other structures to create habitat, stream channel modifications, gravel augmentation, riparian restoration, and a host of other activities.

Both Pacific and Western brook lamprey are considered an "at risk species in the state of Oregon and Pacific lamprey are also listed as a state "sensitive species". The urgency of this project is further substantiated by the U.S. Fish and Wildlife Service's Conservation Agreement for Pacific Lamprey, 2012, of which the Cow Creek Tribe and the U.S. Forest Service Region 6 have signed onto. Specifically objective 7, "Identify, secure and enhance watershed conditions contained in the Resource Management Units (RMU) as designated by the USFWS," and objective 8, "Restore Pacific lamprey populations of the RMU's." It is also consistent with the SA 19.2 Long Term Monitoring and Predator Control Program.

The data gathered from this project will establish baseline information for future hydromitigation projects consistent with the current strategic planning process as well as future lamprey management, restoration and conservation actions in relation to climate change and hydropower operations.

Description of hydropower project caused impacts that project is addressing (aquatic, terrestrial and natural resource related including wetland, aquatic & terrestrial connectivity, vegetation management, soil loss/erosion, etc.). Be specific how/what the project mitigates:

This project will address native lampreys, which represent a culturally and economically important resource in the North Umpqua River basin. Although anadromous salmon and steelhead are relatively well-known in the basin, lampreys are poorly understood. These species must be understood to address the management goals specified in the 2003 FERC Settlement Agreement so they are adequately addressed as part of required mitigation.

When the North Umpqua hydroelectric project was constructed, it cut off fish passage in the upper North Umpqua River and affected natural downstream processes including gravel and sediment deposition. Much attention has been paid to recovery of salmonids and available salmonid habitat within the project area. However, little information on habitat availability for Pacific and Western brook lamprey has been gathered, aside from the previously funded mitigation project to map lamprey habitat above Soda Springs Dam which was spearheaded through a partnership with the Umpqua National Forest Diamond Lake Ranger District and the Cow Creek Tribe. ***Both that project and this proposal are expected to inform impact mitigation opportunities and future restoration prioritization at a critical time when hydropower impacts are being reviewed by the Forest Service and its partners.***

Building off of that previous project to map lamprey habitat above Soda Springs Dam, it is important to examine lamprey presence and habitat characteristics throughout the area of hydropower impacts. With accumulation of sediment behind the dam, direct impacts on downstream areas may lead to reductions in available lamprey habitats (i.e., presence of fine sediment for larvae to burrow into). Accordingly, many required mitigation activities include managing in-stream geomorphic processes, aquatic habitat connectivity, instream flows, and off-site mitigation.

In summary, we will provide the requisite information for explicitly considering the needs and responses of native lampreys as a host of activities required for hydro-mitigation are carried out. This will improve the chances that hydro-mitigation will have positive and measurable benefits, not only for anadromous salmon and steelhead, but also for native lamprey.

We have established the importance of considering lamprey via collaborative work in Little Wolf Creek in the mainstem Umpqua. In that system, restoration has targeted salmonids, but research has shown limited value to salmonids, whereas in-stream wood placement has benefited habitat for larval and transforming (eyed) lamprey. Without this work, we would not have understood the benefits of this restoration for lamprey and potentially under-valued the benefit of the overall project. Such relationships have yet to be explored in the North Umpqua River, where a variety of geological and hydrological differences may lead to different outcomes. This work will provide an opportunity to consider lamprey in restoration.

Point of hydropower induced impact:

Legal: T_____ R _____ Sect. _____

6th field subwatershed: _____

5th field watershed: _____

Administrative Unit: _____

Location of proposed mitigation project:

Legal: T_____ R _____ Sect. _____

6th field subwatershed: _____

5th field watershed: _____

Administrative Unit: _____

Note – We did not fill out coordinates, as our project would occur across the entire North Umpqua basin.

Description of project objectives, activities, *measurable* benefits, and expected accomplishments:

The primary *project objective* is to quantify and model presence of larval lamprey throughout the North Umpqua basin within areas directly or indirectly influenced by hydropower operations. Larval lamprey is our focus, as they are present in the river for 3-7 years or more, and are much more poorly understood than adult life stages.

The main *activities* would involve field work to develop and implement protocols to detect larval lamprey, data analysis, and communication of results orally and in writing. Expected accomplishments include models and maps to predict the distributions of larval lamprey, identification of limiting factors, and information that can be used to evaluate or prioritize mitigation activities.

Measurable benefits include an improved ability to explicitly consider and quantify responses of lamprey in mitigation activities. With information from this project in hand, influences of management on lamprey can be considered alongside other priorities. This work is in partnership with the Umpqua National Forest, the U.S. Geological Survey, and the Cow Creek Umpqua Tribe.

Identify any previous work completed (prior year accomplishment of multi-year project, planning, design work, etc.):

In 2013, the Tribe and the Umpqua National Forest applied for and received hydromitigation funding for lamprey habitat surveys above Soda Springs Dam. The report from that project is available for review and will be useful for future lamprey work in and outside of the Umpqua basin. For instance, this initial survey investment provides a site-specific description of the range of suitable (and non-suitable) habitats for lamprey spawning and rearing. This habitat data is unique to lamprey and has the potential to significantly inform future aquatic restoration designs and mitigation priorities.

This project is the next step in continuing lamprey conservation work in the North Umpqua basin, specifically related to impacts from the hydropower project including but not limited to altered run timing, inaccessibility to historical spawning grounds, and altered sediment transport directly affecting spawning and rearing quantity, quality and locations.

Field surveys will build on pilot work initiated in 2013 aimed at starting basin-wide surveys for larval lamprey, in cooperation with the Cow Creek Umpqua Tribe. In addition to the USGS and the Tribe, partners for the pilot project included the BLM, ODFW and USFS. In total, over 60 sites were sampled (electrofished and physical habitat sampled) for lamprey presence. The information gathered from the pilot will feed into the lamprey models. The Tribe and its partners plan to continue this work in 2014 and are offering a match for this project (see budget for description).

Assessments of habitat will also benefit from a concurrent funded study of sediment transport in the Umpqua River basin, in cooperation with the U.S. Geological Survey, Oregon Water Science Center. This study will allow us to understand where physical constraints occur on the potential for different streams to support habitat for lamprey, namely the distribution of fine sediment at basinwide and reach extents. At the reach extent this study will also evaluate the effects of local restoration activities in the context of basinwide controls on sediment. Work proposed here will provide a valuable biological component to this study.

Given the lack of knowledge about lamprey ecology, any research and monitoring that is conducted for lamprey in the Umpqua will be beneficial to researchers and fisheries managers both within and outside of the Umpqua basin. All of the afore-mentioned projects including the work proposed for this round of mitigation funding will be applicable to lamprey conservation throughout the Pacific Northwest.

Proposed budget[1]:

FY 2014 (Oct 2014-Sept 2015)

Activity	*Personnel*	*Contract/ Materials*	*Vehicles*	*Total*
Monitoring	$60,000[2]		$1800	$61,800
Analysis	$10,000			$10,000
Report preparation	$10,000			$10,000
Subtotals	$70,000		$1800	$81,800
Overhead (44%)				$35,992
Grand total				**$99,860**

[1] In-kind matching is not considered herein, and contributed base support from USGS would reduce the effective rate of overhead specified (44%)

[2] Assumes the duty station is Glide Oregon, thus no per diem provided

Identify other funding (includes appropriated funds) or confirmed, external partnerships of project[3]

Source	Value of contribution	Description of contribution
Cow Creek Umpqua Tribe (Leader) cooperative lamprey surveys (2013)	$24,960	Contributed (complete) Data from previous work will support this project
Cow Creek Umpqua Tribe cooperative lamprey surveys 2014	$5,000	In-kind match for tribal fisheries crew to perform lamprey presence surveys (confirmed)
U.S. Geological Survey Sediment Transport Study	$150,000	Contributed (confirmed)
U.S. Geological Survey salary	$30,000	In-kind (confirmed) – offsets overhead of $35,000

Proposed project schedule and timeline, including projected date of accomplishment:

FY 2015 – Project initiation, development of statement of work, permits, planning, and implementation of first summer field season

FY 2016 –Complete analysis and write-up of report from 2015 field season, deliver to partners for review – completed by 30 November 2017

[3] We will seek additional external funding to provide value-added for this effort – i.e., more funds for field surveys, development of decision support tools, etc., as directed by partners in the watershed.

Supplemental information – Project detail

BACKGROUND

Objectives in this proposal are focused on developing the tools necessary for monitoring, evaluation, conservation planning, and action to restore Pacific lamprey *Entosphenus tridentatus* and closely related, ecologically similar species (e.g., sympatric species in the genus *Lampetra*) in the North Umpqua River basin. Conservation of native lamprey is a growing concern in the region given their "at risk status" and specifically a top priority in most tribal fisheries programs, including the Cow Creek Umpqua Tribe, a major partner in the proposed lamprey project. Lampreys are a traditional first food source and are considered an ecologically and culturally significant species.

Lampreys should be especially vulnerable to changes in river flows because larvae typically live 4-6 years in stream sediments before transforming into adults or emigrating to the sea, depending on the species (Beamish and Levings 1991; van de Wetering 1998; Brown et al. 2009). Relative to salmon and trout, the larvae of lamprey use much finer sediments (Torgersen and Close 2004, Goodwin et al. 2008), which are more easily scoured and transported during higher flood events anticipated with land use effects (Jones and Grant 1996) and potentially with climate change in the region (Chang and Jones 2011). Larvae are also sensitive to temperature, with incidence of mortality and developmental abnormalities increasing significantly as rearing temperatures increase from 18-20°C (Meeuwig et al. 2005). We suspect larvae may be particularly important, but other life stages of lamprey may also be vulnerable (e.g., requirements for adult refuge from high winter flows, temperature sensitivity; (Clemens 2011, Lampman 2011). Our focus here is on larval life stages.

OBJECTIVES

The objectives of this work are to 1) map the potential for various streams and their associated habitats to support lamprey; 2) identify those streams and habitats that are the most important for lamprey; and 3) use that information to plan for conservation and restoration of the lamprey in the North Umpqua basin.

In order to achieve these objectives we will 1) use recently validated sampling protocols to quantify distribution and abundance of lamprey; 2) based on these data, develop estimates for presence and abundance of lamprey based on key factors hypothesized to be important (e.g., stream size, flow, temperature, substrate); 3) predict the potential for streams to support lamprey; and 4) develop ways to apply this information directly to hydro-mitigation in the North Umpqua basin.

PROCEDURES/METHODS:
We have organized our description of procedures and methods within the context of each listed study objective, as follows:

Quantify distribution and abundance. Site selection (Fig. 1) follows the EPA-EMAP design to provide spatially balanced representation of streams within our study area (Larsen et al. 2008). Our focus in this work is on wadeable streams, as they represent the

vast majority of available habitats in stream networks and areas of greatest uncertainty with respect to lamprey (K. Coates and S. van de Wetering, personal observations).

We will work to assemble data on presence of lamprey across the study area, as well as our own field sampling to provide information that can be contributed to this effort. Field sampling is an expensive endeavor and the consequence is limited sample sizes and inference. Here, we will adopt a Bayesian approach (e.g., Gelman et al. 2003; Peterson and Dunham 2003; Wenger and Freeman 2005) to use these data as prior information in this work. More specifically these data or model predictions derived from them can be incorporated into model predictions of species presence.

Field sampling and identification of larval lamprey (Goodman et al. 2009) will follow protocols we have developed and implemented (Dunham et al. 2013) with the addition of mark-recapture to estimate capture probabilities. Marking will involve use of visible implants, which we have used extensively in the past on lamprey and other species (e.g., other fishes and amphibians). We will use backpack electrofishing to capture lamprey and other fish, using standard settings first to capture species other than lamprey, followed by a pass with lamprey-specific settings. This allows us to efficiently capture and estimate numbers of all fishes in our sampling, not just lamprey. This project will also provide data that can be used to predict presence of other native species, or that of invaders, such as smallmouth bass (e.g., Lawrence et al. 2012).

Although we will consider all sizes of lamprey captured in evaluating presence, inferences about abundance of lamprey will be limited to larvae larger than about 75mm (approximately four years or older; van de Wetering 1998) in total length, as these are more common in our catch (Dunham et al. 2013) and can be captured and processed for estimation of capture probability. Our focus here is on presence of larval lamprey and not other life stages. Habitat variables quantified at sites will include standard measures of channel form (e.g., variability in depth and width), temperature, and sediment characteristics (particle diameter distributions and sediment depths).

Models to estimate capture probabilities, detectability, and presence. As discussed above we will rely on Bayesian inference to allow for increased flexibility in parameter estimation and incorporation of prior information, allowing us to use as much available information as possible to complement field data collected in this effort. Estimation of capture probabilities will be based on variables measured at sites. We will also model lamprey presence based on these site-based variables to evaluate predictions from hypotheses about the effects of local habitat and species interactions. Models to predict presence of larval lamprey will be used for mapping purposes (not the same as testing hypotheses about local variables) and will of necessity focus on map-based covariates that are available across the study area.

Map-based covariates will be partitioned into those that account for fixed landscape characteristics, such as land form, geology, and location (e.g., Burnett et al. 2007; Wigington et al. 2013), and a focus on dynamic and climate-sensitive variables such as temperature and flow-related variables. Temperatures will be predicted as part of the NorWEST effort, funded by the North Pacific and Great Northern Landscape Conservation Cooperatives (Dunham is a collaborator on these efforts). Flow-related statistics will be acquired from downscaled models developed by Wenger et al. (2010).

Map-based predictions derived from these variables have been successfully applied to predicting thermal habitat loss for fish (Isaak et al. 2010) and flow-related changes in fish distributions in the face of future climate scenarios (Wenger et al. 2011a). In addition to climate-related predictors described above, we will seek to apply other complementary tools, such as NetMap (Benda et al. 2007) which are in use now for evaluating future hydrogeomorphic conditions in response to future land management and climate scenarios in western Oregon (Lee Benda, Earth Systems Institute, personal communication; Gordie Reeves, U.S. Forest Service Pacific Northwest Research Station, personal communication).

Map the potential for streams to support lamprey. With model predictions in place we can apply them to map predicted presence of lamprey across the North Umpqua basin including an assessment of uncertainty in model prediction (e.g., Wiens et al. 2009). This provides a robust and efficient view of the potential of streams to support lamprey across this broad extent – something that is not possible via a census effort, given that there are literally hundreds of km of stream that would need to be covered.

Conservation actions to protect and restore lamprey. New information provided herein will contribute greatly to our ability to identify actions that are most likely to benefit lamprey.

First, we will deliver a new protocol that can be applied to robust estimation of both presence and abundance of lamprey. This protocol can be easily applied by field biologists, but some assistance from statistical specialists will likely be needed in data analysis. That said this will represent a major advance in our ability to quantitatively evaluate the status of lamprey, a goal that has been consistently listed for years as a top priority in conservation of lamprey in the Northwest, but yet to be addressed.

Second, as mentioned above, we will apply responses of lamprey to identify what threats are most important in terms of influencing the distribution or abundance of lamprey. This represents a huge complement to existing approaches for evaluating threats because it is based directly on how fish respond to measurable conditions at sites and across broad landscapes. In short, we need to know 1) patterns of species abundance and distribution, and 2) what factors influence #1 if we are to develop effective mitigation measures. Mitigation actions can thus be focused to address key locations or factors known to influence lamprey rather than on actions with unknown benefits.

Third, the long-term value of mitigation actions can be evaluated in the context of projected changes associated with future climates (e.g., temperatures and flow), again based on models developed in this project. For example, some projects may only benefit lamprey in the short-term if we are relatively certain that climate-related changes in habitat will shift the distribution of lamprey outside of the project area.